January 30, 2018

Ex Parte

Marlene H. Dortch, Secretary
Federal Communications Commission
445 12th Street SW
Washington, DC 20554

Re: Expanding Flexible Use in Mid-Band Spectrum Between 3.7 and 24 GHz, GN Docket No. 17-183

Dear Ms. Dortch:

On Friday, January 26, 2018, Kumar Balachandran, Paul Challoner, Jonas Edstam, Evanny Obregon and Mark Racek of Ericsson met with Bahman Badipour, Michael Ha, Nick Oros, Brian Butler, Barbara Pavon, Karen Rackley and Ron Repasi of the OET; Jose Albuquerque, Chris Bair, and Diane Garfield of the IB; Stephen Buenzow, Peter Daronco, Tom Derenge, Arial Diamond, Becky Schwartz, Blaise Scinto and Janet Young of the WTB to discuss the critical importance of mid-band spectrum and its particular role in meeting the booming demand for terrestrial broadband, including 5G service.

Consistent with our comments in this docket, Ericsson discussed licensed opportunities in the 3.7-4.2 GHz band using a variety of clearing options, including market-based mechanisms, while emphasizing the need for regulatory certainty.[1] Ericsson is less optimistic that wireless broadband systems and C-band earth stations will be able to share the 3.7-4.2 GHz band on a co-channel basis. Ericsson presented its study that concludes co-channel sharing between single IMT Macro basestation ("BS") nodes and Fixed Satellite Service ("FSS") earth station receivers requires large separation distances, and considering that 65% of FSS receivers are located in urban/sub-urban locations, such large separation distances will eliminate co-channel sharing possibilities in the populated areas. Sharing between IMT BS and FSS, assuming band segmentation and a typical urban deployment, could be more viable depending on the assumptions made for the FSS receiver filter characteristics.

Ericsson also supports unlicensed and licensed opportunities in the 5.925-6.425 GHz and 6.425-7.125 GHz bands, respectively, provided that incumbent fixed service point-to-point operations are protected from harmful interference and that unlicensed use in 5.925-6.425 GHz is on a technology neutral basis.

Ericsson supports the existence of long-haul point-to-point links where needed, especially in rural areas. Ericsson presented an overview of the U.S. and global microwave backhaul spectrum use

[1] *See* Comments of Ericsson, *Expanding Flexible Use in Mid-Band Spectrum Between 3.7 and 24 GHz*, GN Docket 17-183, Filed Oct. 2, 2017, at 7-9.

1776 I St., NW Suite 240
Washington, DC 20006
Tel: +1 202 824 0110
mark.racek@ericsson.com

ERICSSON

emphasizing that the amount of backhaul spectrum in the United States lags that in other parts of the world, particularly below 10 GHz and this will only get worse with 5G. Ericsson discussed regulatory trends and innovations to facilitate microwave gigabit transport. Ericsson supports NTIA and Commission action to open the 7 and 8 GHz bands for shared non-federal fixed service use. This band could serve to support urban and suburban fixed service relocation from the upper half of the 6 GHz band, for instance. Ericsson also supports enhanced long-haul backhaul service in the 6 GHz band.

We also noted the limited opportunities for additional licensed mobile use allocations between 7 and 24 GHz and urged more federal/non-federal shared bands in these frequencies.

Respectfully submitted,

/s/ Mark Racek

Mark Racek
Sr. Dir Spectrum Policy,
Government Affairs and Public Policy
Ericsson

1776 I St., NW Suite 240
Washington, DC 20006
Tel: +1 202 824 0110
mark.racek@ericsson.com

EXPANDING FLEXIBLE USE IN MID-BAND SPECTRUM BETWEEN 3.7 AND 24 GHZ

GN Docket No. 17-183

AGENDA

Overview

Co-existence Study

Microwave Backhaul Spectrum

OVERVIEW

Mid-band spectrum for 5G

- 1) Pursue flexible-use licensed opportunities in the 3.7-4.2 GHz band using market-based mechanisms to clear that spectrum;
- 2) Explore the introduction of new licensed opportunities in the 6.425-7.125 GHz bands;
- 3) Pursue unlicensed opportunities in the 5.925-6.425 GHz with an emphasis on rules that render the band neutral to choice of technology;
- 4) Ensure that incumbent fixed service point-to-point operations in the 5.925-6.425 GHz and 6.425-7.125 GHz bands are protected from harmful interference;
- 5) Examine whether to transition the 7.125-8.5 GHz band from an exclusive federal band to a shared one; and
- 6) Adopt changes to existing long-haul backhaul rules to better support, next-generation, high-throughput services.

CO-EXISTENCE BETWEEN IMT AND FSS

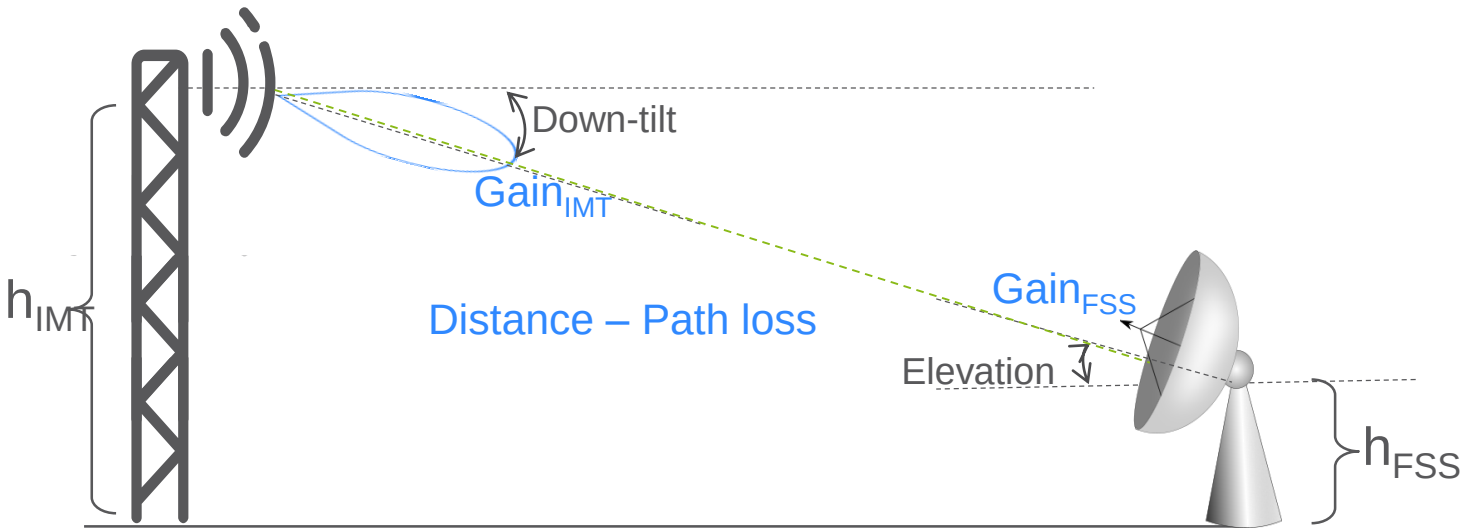
Dr. Evanny Obregon

CO-EXISTENCE STUDY

Objective

› Analysis of co-channel and adjacent-channel sharing between FSS and IMT (BS Macro) in the 3.7 – 4.2 GHz band

Sharing Scenario



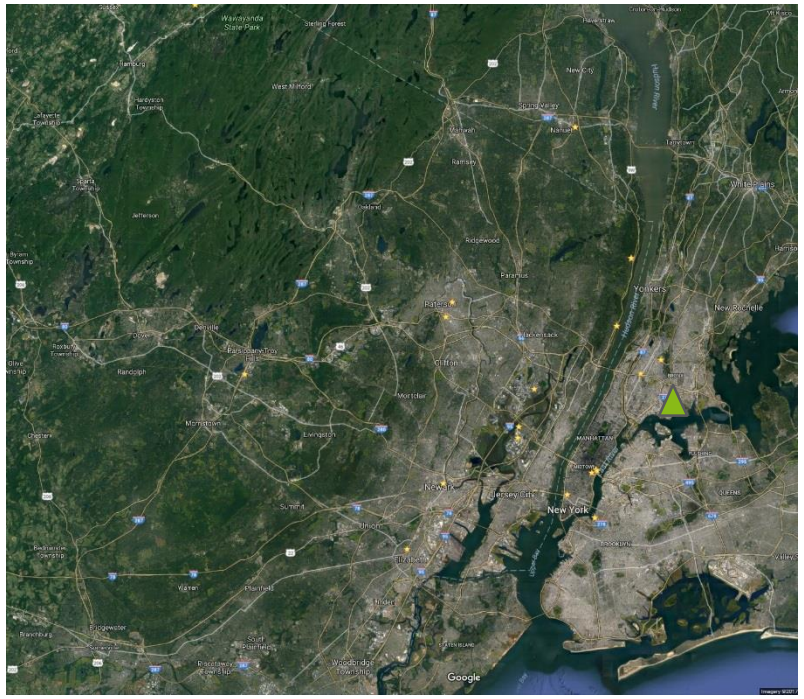
› Propagation model
  - ITU-R P.452-16 (ITU-R SG3 implementation)
    - Flat earth is assumed. Thus, model is valid roughly up to 50Km link distance
  - Flat terrain profile
  - Clutter losses at the Transmitter and Receiver side
› Long-term interference criterion
› Apportionment of interference allowance
  - half of the total noise interference allowance into an FSS link: 3dB

CO-EXISTENCE STUDY

IMT Transmitter		
Base station deployment	Macro suburban	Macro Urban
Antenna height (m)	25	20
Downtilt (degrees)	6	10
Antenna characteristics	ITU-R F.1336 (recommends 3.1) Ka =0.7, Kp=0.7, kh=0.7 ; kv=0.3 Horizontal 3 dB beam width: 65 degrees Vertical 3 dB beam width: determined from the horizontal beam width	
Feeder loss (dB)	3	
Maximum base station output power	46 dBm/10MHz	
Filter characteristics	3GPP TS 36.104 v.14.4.0 6.6(single tx)	

FSS Receiver		
Earth station deployment	Sub-Urban	Urban
Channel Bandwidth (MHz)	36	
Antenna Gain (dBi)	49.9	38
Antenna diameters[1] (m)	9	2.4
Antenna pattern	ITU-R Recommendation S.465	
Receiver system noise temperature (K)	70	100
Above ground level (m)	10	30
Elevation angles (degrees)	5, 20 and 40	
Filter characteristics	IMT-like: ACS of 45dB Conservative: ITU-R S.2368-0 p.147	

Specific terrain profile

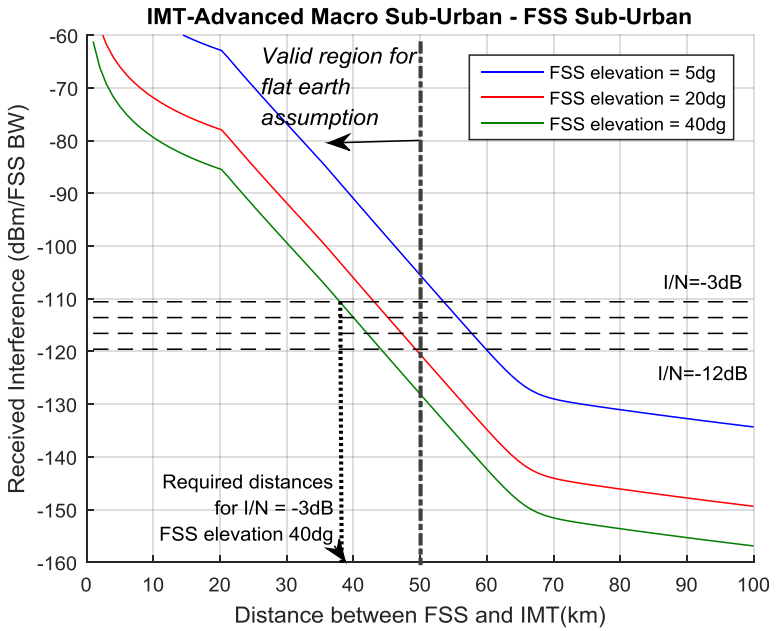


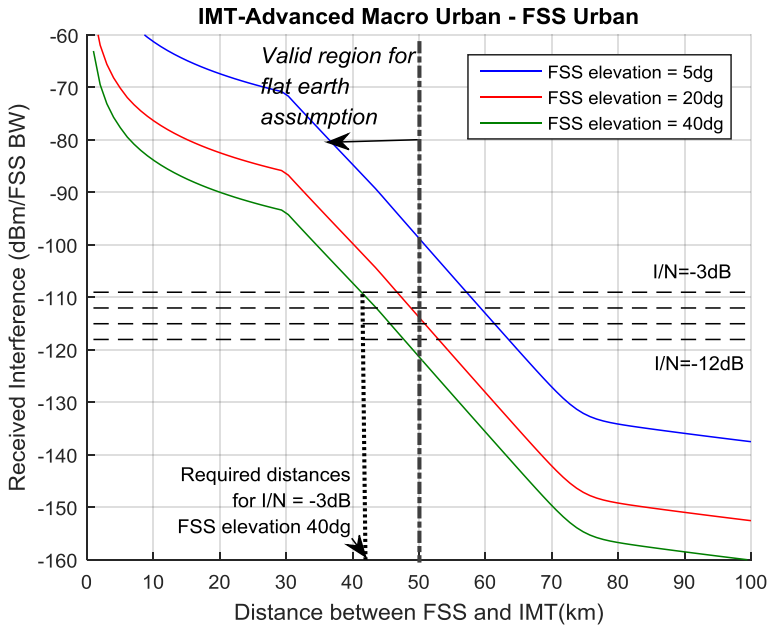
The area covers an area around New York, 7 298 sq km.

[1] FSS antennas in this band may be deployed in a variety of environments. Smaller antennas (1.8-3.8 meters) are commonly deployed on the rooftops, whereas larger antennas are typically mounted on the ground and deployed in semi-urban or rural locations. 5° is considered as the minimum operational elevation angle.

CO-CHANNEL SHARING

Single IMT BS transmitter, ITU-R F.1336 antenna pattern





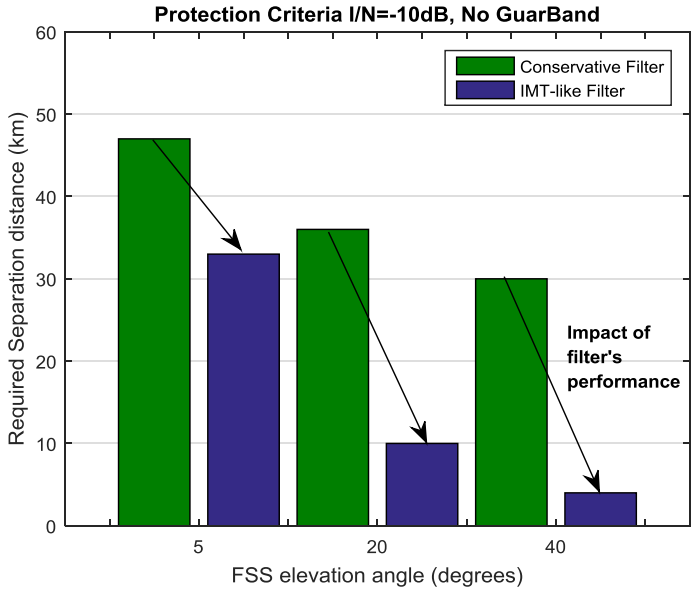
Co-channel sharing leads the large separation distances, i.e. >30Km, that diminishes sharing possibilities in the populated areas

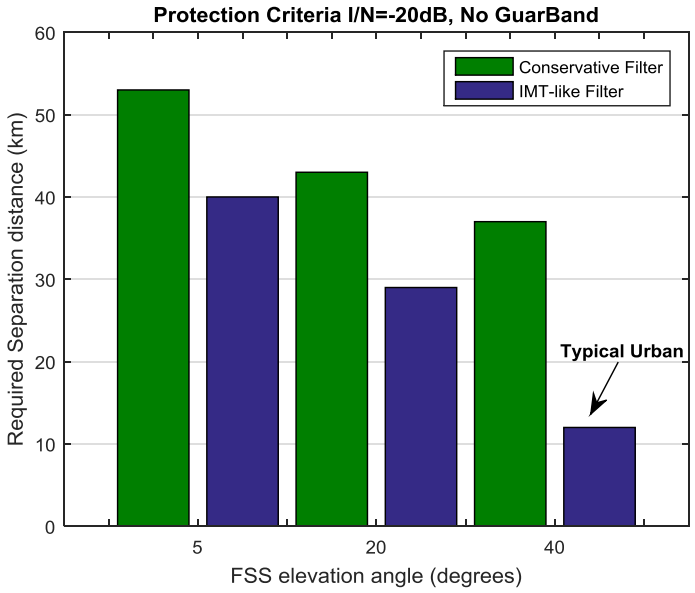
ADJACENT CHANNEL SHARING

IMT BS Macro Urban vs FSS Urban

Single IMT BS transmitter, ITU-R F.1336 antenna pattern

No guard band



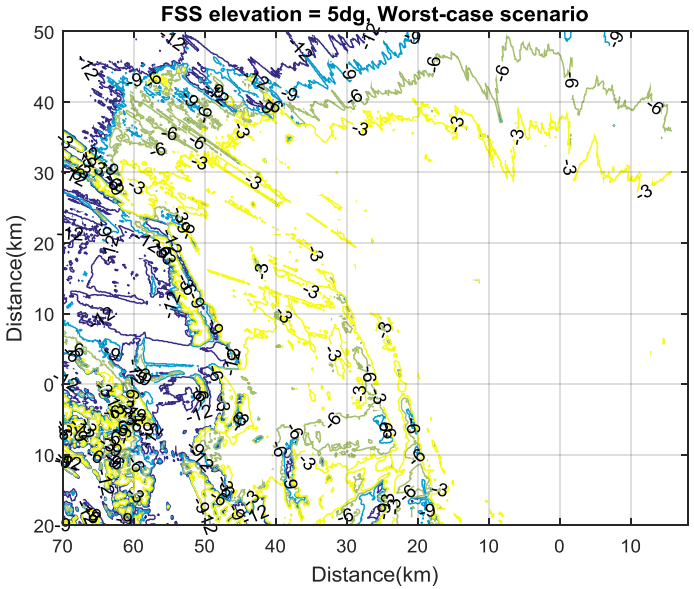


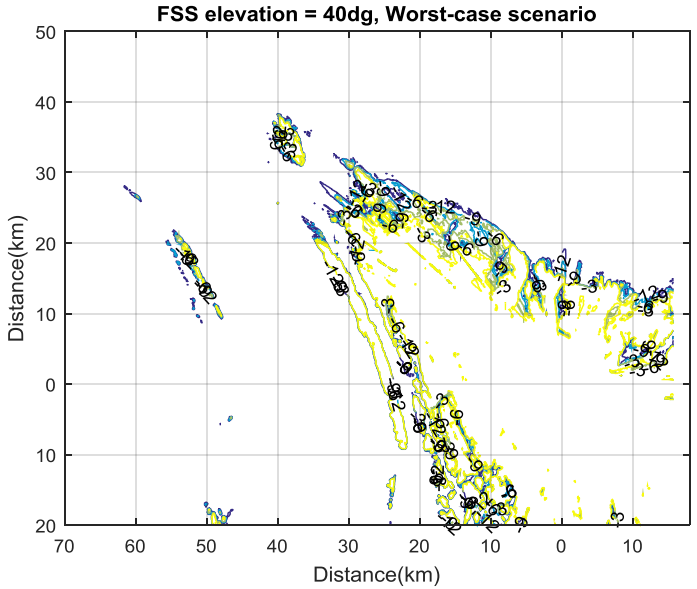
FSS receiver filter characteristics strongly impacts adjacent-channel sharing

Separation distances in typical urban deployment (>=40°) are reasonably short even for I/N=-20dB and no guard band with an IMT-like filter

CO-CHANNEL SHARING URBAN

Assumptions:
Single IMT BS transmitter in each bin, ITU-R F.1336 antenna pattern
FSS pointing towards the IMT BS, with a given elevation angle
FSS located in coordinate (0,0)



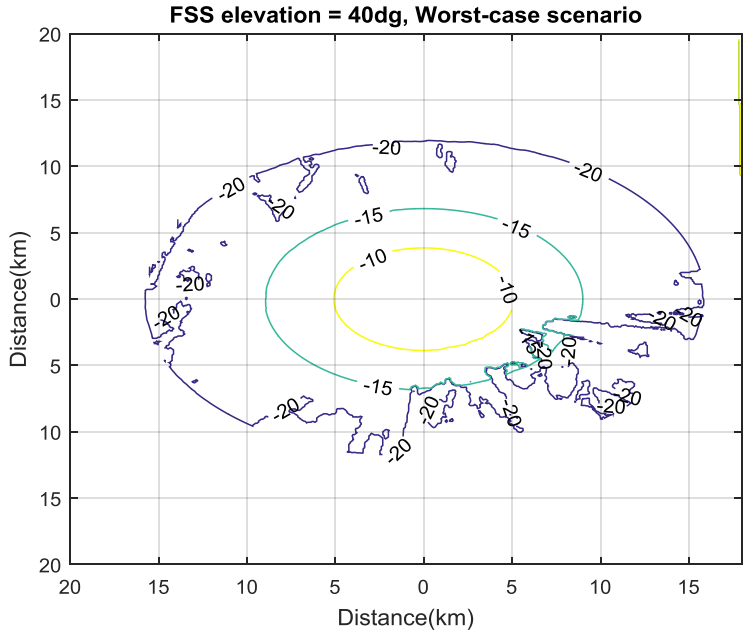


Impact of real terrain profile reduces separation distances compared to the ones without terrain profile, however co-channel sharing still leads the large separation distances

More relaxed FSS protection criteria, i.e. I/N, have marginal impact

ADJACENT CHANNEL SHARING URBAN

Assumptions:
Single IMT BS transmitter in each bin, ITU-R F.1336 antenna pattern
Guard band of 5MHz
FSS with IMT-like filter, FSS located in coordinate (0,0)



Compared to co-channel case, adjacent channel sharing leads to smaller separation Distances, i.e. less than 5Km for I/N of -10dB

CONCLUSIONS

- Co-channel sharing between single IMT Macro BS nodes and FSS earth station receivers leads the large separation distances, i.e. >30Km with no terrain data and >10Km with specific terrain data
- Considering that 65% of FSS receivers are located in urban/sub-urban locations, such large separation distances will eliminate co-channel sharing possibilities in the populated areas
- Adjacent-channel sharing between IMT BS and FSS with typical urban deployment seems more viable
  - Separation distance shorter than 12Km for I/N=-20dB when FSS receiver has an IMT-like filter and an elevation angle of 40 degrees
- FSS receiver filter characteristics strongly impacts required separation distances and guard band in adjacent-channel sharing

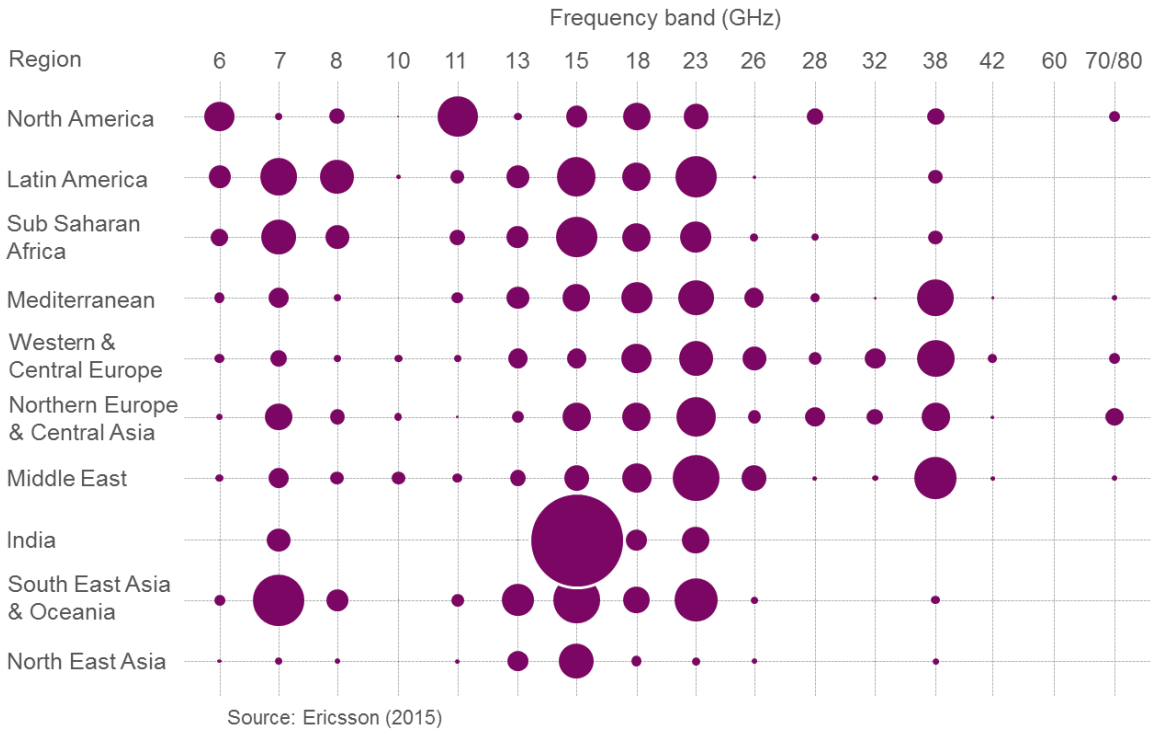
ERICSSON

MICROWAVE BACKHAUL SPECTRUM

Dr. Jonas Edstam

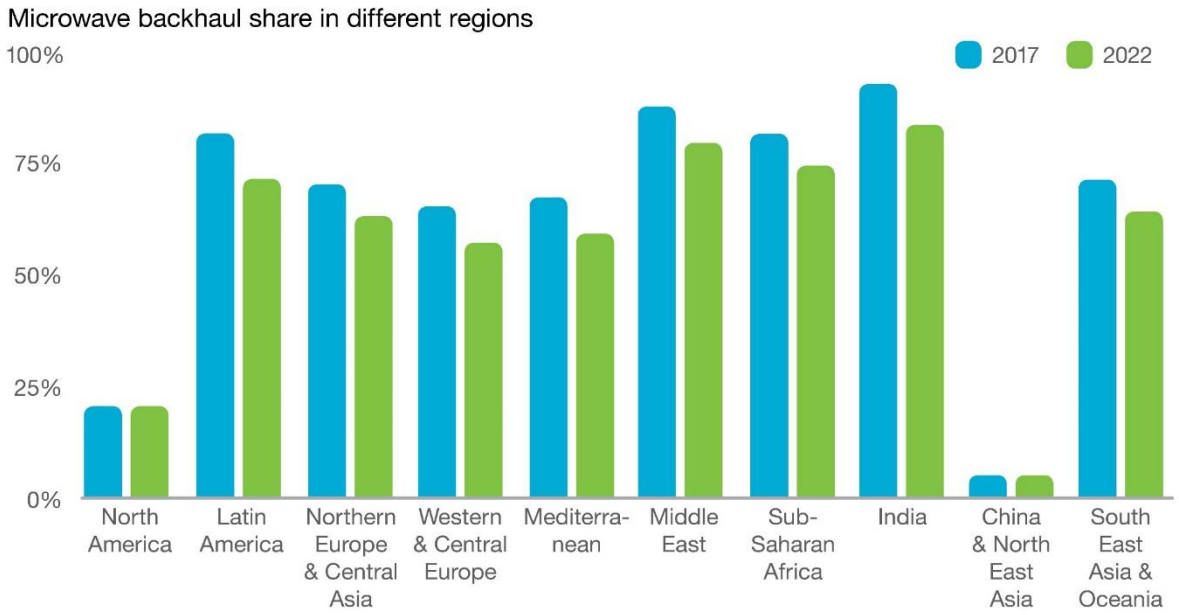
MICROWAVE BACKHAUL SPECTRUM
Global use

Spectrum use



Source: Ericsson (2015)

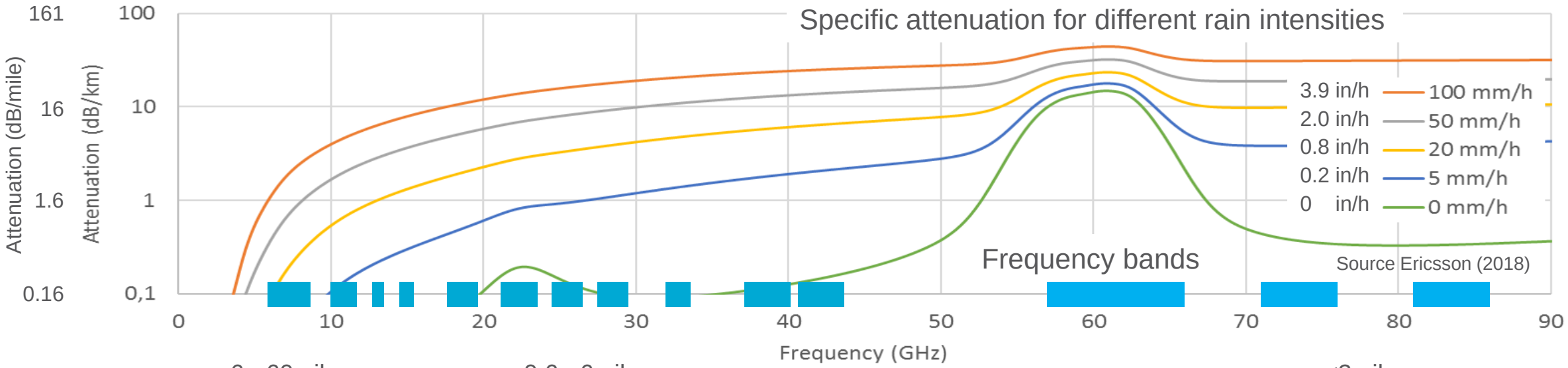
Mobile backhaul media



Source: Ericsson (2017)

MICROWAVE BACKHAUL SPECTRUM

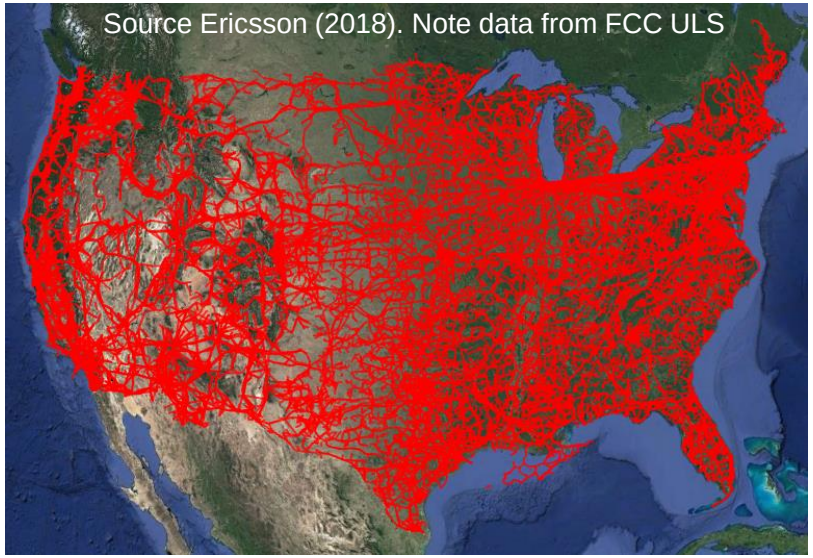
Global use



Hop lengths	6 - 60miles 10 - 100km	0.6 - 6miles 1 - 10km	<2miles <3km
Channels	Up to 60 MHz	Up to 112 MHz	Up to 2000 MHz
Capacity per carrier	Up to 600 Mbps	Up to 1200 Mbps	Up to 10 Gbps
Link configurations	Typically 2-8 carriers Up to 16 carriers occur	Typically 1-2 carriers Up to 4 carriers occur	Typically 1 carrier

MICROWAVE BACKHAUL SPECTRUM

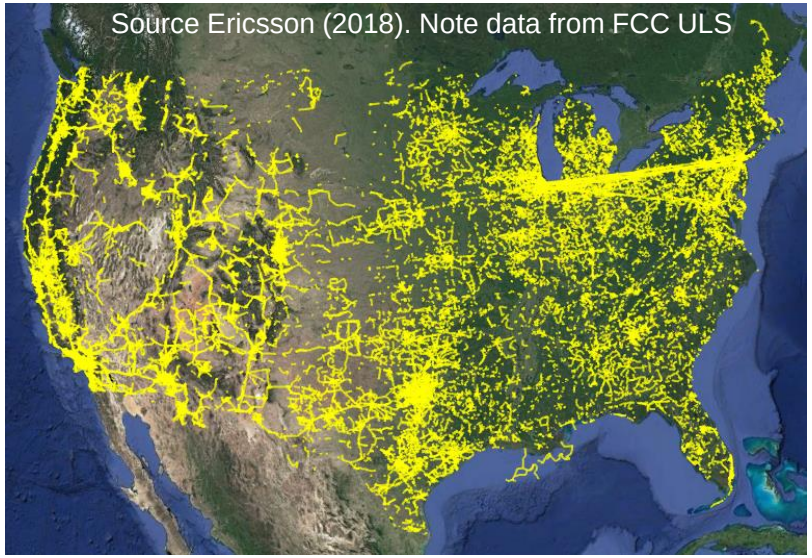
Main use below 24GHz in USA



6GHz

6-60 miles range

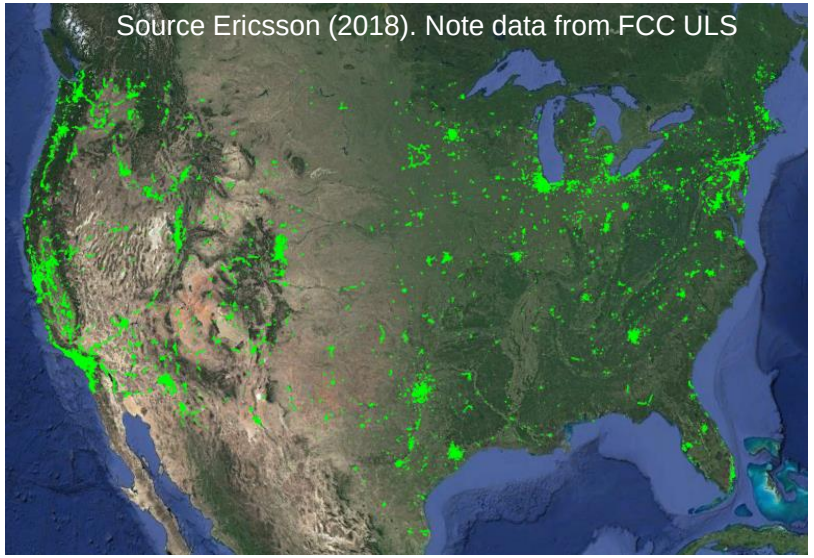
10-100 km range



11GHz

2-20 miles range

3-30 km range



18 and 23GHz

0.6-6 miles range

1-10 km range

MICROWAVE BACKHAUL SPECTRUM

Main use below 24GHz in USA

Frequency bands	6	11	18	23
	5.925-6.425GHz	6.525-6.875GHz	10.7-11.7GHz	17.74-18.14 / 19.3-19.7GHz	21.2-23.6GHz
	4x 60MHz channels	5x 30MHz channels	6x 80MHz channels	4x 80MHz channels	24x 50MHz channels

The gigabit era require at least 60MHz wide channels

One 1Gbps link

~60MHz
(single channel)

Solutions scaling up towards 10Gbps is of growing interest

One 10Gbps link

~560MHz
(aggregated channels)

Note: Spectrum per link drawn to same scale as frequency bands above

THE 7 AND 8 GHZ BAND
7125-8500 MHz

- Reserved for federal use in USA

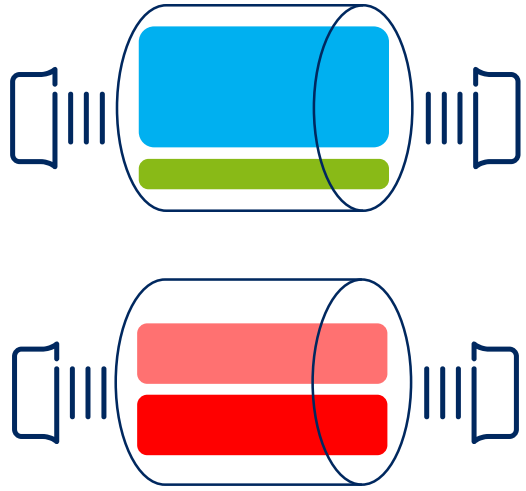
- Globally an essential band for long range Fixed Service use (point-to-point)
- In many countries parts of the frequency range are used for military satellite communications and fixed service links
- Different sharing arrangements and band segmentations exist
  - See for example:
    - Europe: ECC Recommendation (02)06 and ECC Report 163
    - Canada: SRSP-307.1, SRSP.307-7 and SRSP-308.2
    - ITU-R F.385 and F.386

- The band should be opened for shared non-federal fixed service usage
  - At least 60MHz wide channels to support high capacities

MICROWAVE BACKHAUL SPECTRUM
Use in the Gigabit era

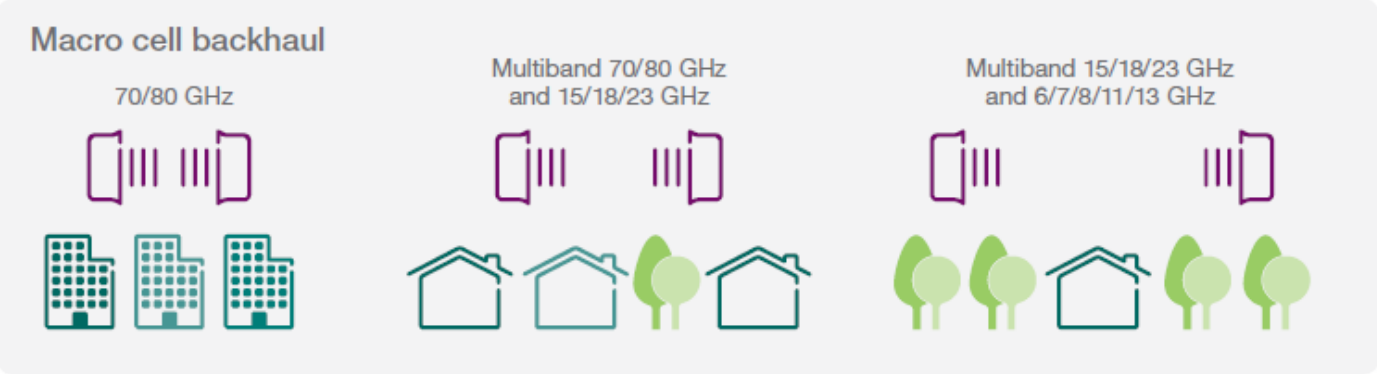
- Regulatory trends to facilitate gigabit transport
  - Introduction of wider channels
  - Review and modernization of frequency bands
    - Example: ECC Report 235. Assessing joint use of 5925-6425 MHz and 6425-7125 MHz http://www.erodocdb.dk/Docs/doc98/official/pdf/ECCREP235.PDF

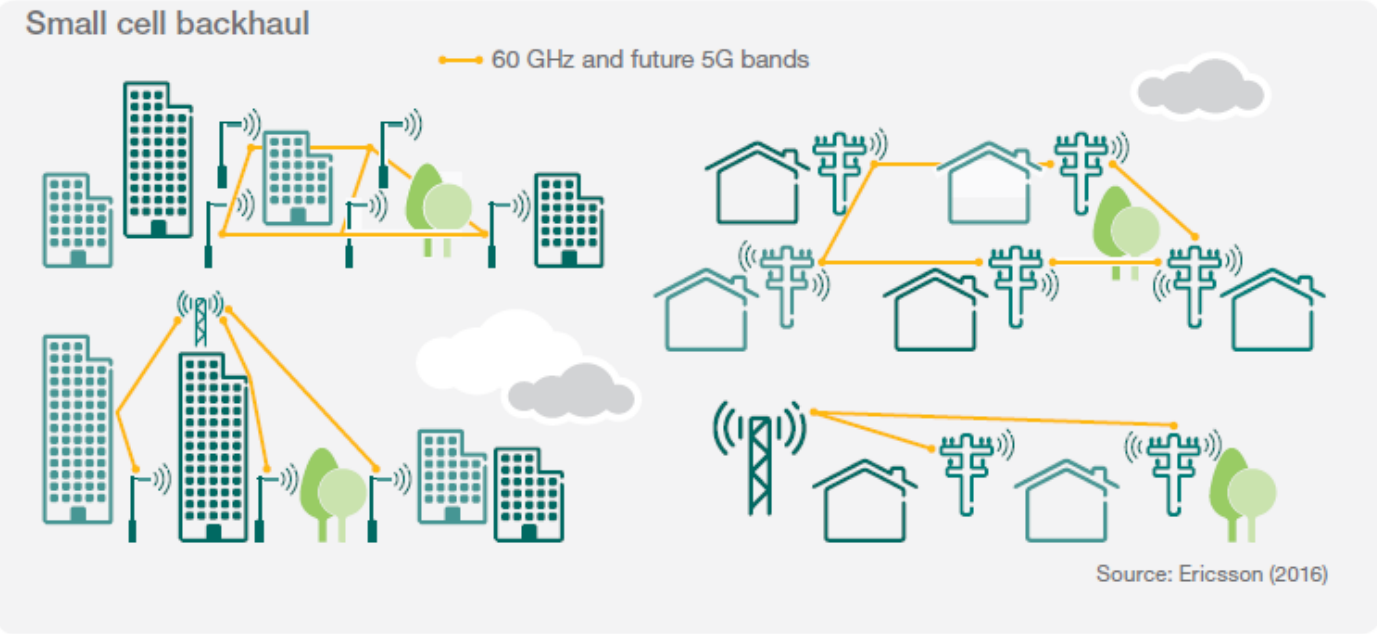
- Multi-gigabit innovations
  - Multi-band booster solutions
    - Equipment combining 70/80GHz with 15, 18 or 23GHz
  - Adjacent band solutions
    - Equipment combining 6L with 6U, or 7 with 8GHz

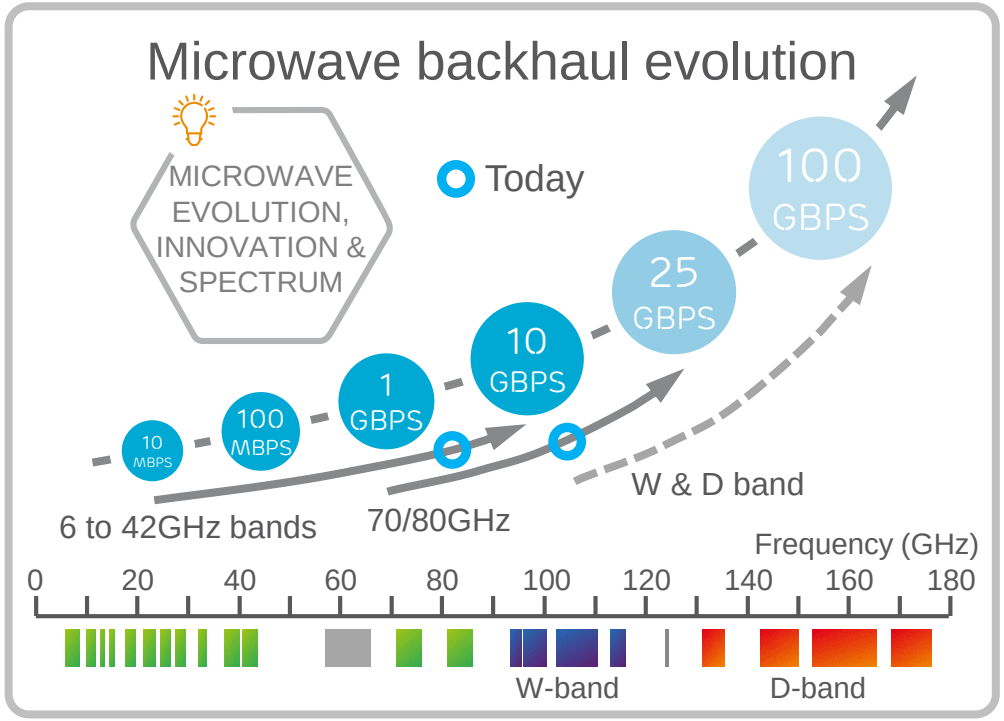


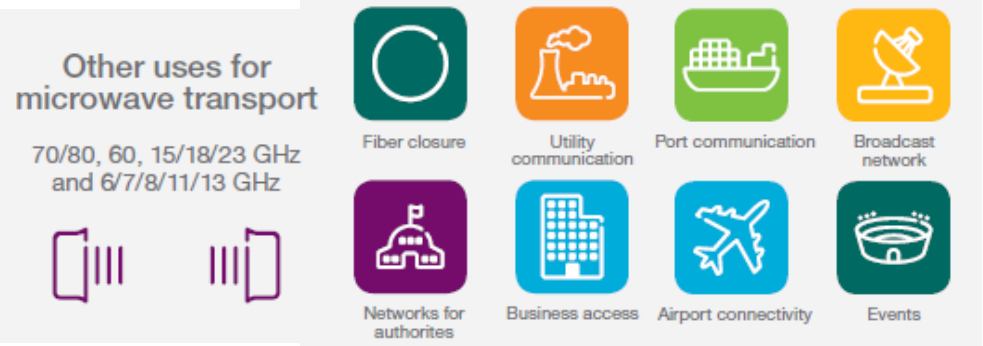
MICROWAVE BACKHAUL SPECTRUM

Use in the Gigabit era









FURTHER READING

- Ericsson Microwave Outlook - annual report
  - https://www.ericsson.com/en/microwave-outlook
- Ericsson Technology Review articles
  - Microwave backhaul evolution - reaching beyond 100GHz
    - https://www.ericsson.com/en/publications/ericsson-technology-review/archive/2017/microwave-backhaul-evolution-reaching-beyond-100ghz
  - Microwave backhaul gets a boost with multiband
    - https://www.ericsson.com/en/publications/ericsson-technology-review/archive/2016/microwave-backhaul-gets-a-boost-with-multiband
- Ericsson Microwave Backhaul product portfolio
  - https://www.ericsson.com/ourportfolio/networks-products/microwave-networks?nav=fgb_101_0859

ERICSSON